



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 15.6.4 RADIOLOGICAL CONSEQUENCES OF MAIN STEAM LINE FAILURE OUTSIDE CONTAINMENT (BWR)

REVIEW RESPONSIBILITIES

Primary - ~~Accident Evaluation Branch (AEB)~~ Emergency Preparedness and Radiation Protection Branch (PERB)²

Secondary - Reactor Systems Branch (~~RSB~~)(SRXB)³

I. AREAS OF REVIEW

The purpose of the review is to calculate the whole body and thyroid doses resulting from a postulated failure of a main steam line outside containment of a BWR facility, and to ~~assure~~⁴ that radioactive releases due to the failure are adequately limited by the technical specifications on primary coolant activity. The review includes two cases for the reactor coolant iodine concentration: (1) with a preaccident iodine spike and (2) with the maximum equilibrium concentration for continued full-power operation.

Review Interfaces⁵

1. A secondary review is performed by the Reactor Systems Branch (~~RSB~~)(SRXB).⁶ The amount of potential fuel failure resulting from the postulated main steam line break (MSLB) accident is routinely evaluated by ~~RSB~~SRXB⁷ and the result provided to the ~~AEB~~PERB⁸ for consideration in the evaluation of the MSLB radiological consequences.
2. The review of the applicable technical specifications is coordinated with and performed by the ~~Licensing Guidance Branch~~ Technical Specifications Branch (TSB)⁹ as part of its primary review responsibility for Standard Review Plan (SRP)¹⁰ Section 16.0. The

DRAFT Rev. 3 - April 1996

USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

acceptance criteria necessary for the review and the method of application are contained in SRP Section 16.0.

For those areas of review identified as part of the primary responsibility of other branches, the acceptance criteria and methods of application are contained in the referenced SRP section.¹¹

II. ACCEPTANCE CRITERIA

The acceptance criteria are based on the requirements of 10 CFR Part 100 as related to the radiological consequences of an accident. The plant site and the dose mitigating engineered safety features (ESF) are acceptable with respect to the radiological consequences of a postulated MSLB outside containment of a BWR facility if the calculated whole body and thyroid doses at the exclusion area and the low population zone boundaries do not exceed the following exposure guidelines:

1. For an MSLB with an assumed preaccident iodine spike corresponding to the maximum iodine concentration stated in the nuclear steam supply system (NSSS)¹² vendor's standard technical specifications, the calculated doses should not exceed the guideline values of 10 CFR Part 100, paragraph 1100.11¹³ (Ref. 1).¹⁴
2. For an MSLB with an assumed iodine concentration corresponding to the equilibrium value for continued full-power operation stated in the NSSS vendor standard technical specifications, the doses should not exceed a small fraction of the above guideline values, i.e., 10% or 25 mSv (2.5 rem) and 300 mSv (30 rem)¹⁵ respectively, for the whole body and thyroid doses.
3. The methodology and assumptions for calculating the radiological consequences should reflect the regulatory positions of Regulatory Guide 1.5¹⁶ (Ref. 2)¹⁷ except for the atmospheric dispersion factors which are reviewed under SRP Section 2.3.4.
4. A plant specific technical specification is required for both cases of iodine activity in the primary coolant. This specification is acceptable if the calculated potential radiological consequences from the MSLB accident are within the exposure guidelines for the above two cases.

Technical Rationale¹⁸

The technical rationale for application of these acceptance criteria is discussed in the following paragraphs:¹⁹

Compliance with 10 CFR 100.11 requires that the exclusion area, low population zone, and population center distance be determined based on a fission product release from the plant and meteorological conditions pertinent to the site.

Identification of an exclusion area, a low population zone, and a population center distance is an integral aspect of the siting criteria for new nuclear power plants. Radiation dose reference values — a total radiation dose to the whole body in excess of 250 mSv (25 rem) or a total

radiation dose to the thyroid from iodine exposure in excess of 3000 mSv (300 rem) — are associated with the exclusion area and the low population zone. To demonstrate that the proposed nuclear plant design will meet these reference values at the exclusion area and low population zone boundaries, a calculation of the expected offsite radiation doses is performed using a radioactive source term based on the concentration of radioactive material in the coolant, the size of the break, the occurrence of an iodine spike before or concurrent with the event, and site atmospheric dispersion characteristics. For an MSLB with an assumed preaccident iodine spike corresponding to the maximum iodine concentration, full reference value doses apply. For an MSLB with an assumed iodine concentration corresponding to the equilibrium value for continued full-power operation, the dose criterion should not exceed a small fraction (i.e., 10%) of the reference value doses.

Meeting the requirements of 10 CFR 100.11 for doses resulting from steam line break accidents provides assurance that offsite radiation doses from the postulated MSLB accident will not exceed the guideline doses specified in 10 CFR Part 100.²⁰

III. REVIEW PROCEDURES

The reviewer selects and emphasizes specific aspects of this Standard Review Plan (SRP) section as appropriate for a particular plant. The judgment of which areas need to be given attention and emphasis in the review is based on the reviewer's determination of ~~determining if the material presented is similar to that recently reviewed on other plants and~~²¹ whether items of special safety significance are involved.

At the construction permit (CP) or standard design certification²² stage, the review is limited to a survey of the pertinent portions of the plant design and the applicant's discussion of the accident to determine that there are no unusual features that would prevent limitation of doses to acceptable levels by appropriate limits on coolant activity concentrations. Standard technical specifications regarding coolant activity concentration limits have been issued for BWR plants and the radiological consequences of a steam line failure have been evaluated for a standard General Electric Standard Safety Analysis Report (GESSAR)²³ plant using this activity limit to determine the limiting atmospheric dispersion factors (χ/Q values). Consequently, the radiological consequences of a steam line failure accident need not be explicitly calculated for a standard GESSAR plant located at a site where the χ/Q value is equal to or less than the limiting χ/Q value.

For standard design certification reviews, the calculation of hypothetical offsite radiological consequences of the main steam line failure is performed using proposed technical specification limits on coolant radioactivity and limits on atmospheric diffusion parameters specified in the site parameter envelope.²⁴

The detailed review of the radiological consequences of a main steam line failure outside containment is done at the operating license (OL) or combined license (COL)²⁵ stage when system parameters, site meteorological characteristics,²⁶ and accident analysis are fully developed. The review at the OL or COL²⁷ stage consists of the following steps:

1. Review of the applicant's description and dose analysis of the main steam line failure accident.
2. Performance of an independent analysis by the staff of the radiological consequences of the failure of the main steam line, using the assumptions of Regulatory Guide 1.5 (Ref. 2),²⁸ except for the atmospheric dispersion factors. The following conservative assumptions are used to simplify the analysis:
 - a. The mass of reactor coolant assumed to be released to the environment is 64,000 kg (140,000 lbs)²⁹ for the "GESSAR 251" sized BWR and 46,000 kg (100,000 lbs)³⁰ for the "GESSAR 238" sized BWR. Other BWRs should be evaluated on a case-by-case basis. The release is assumed to occur instantaneously. These assumptions are made unless notified otherwise by RSBSRXB.³¹
 - b. The iodine concentration in the primary coolant is assumed to correspond to the following two cases in the NSSS vendor's standard technical specifications:
 - (1) The concentration is the maximum value permitted and corresponds to the conditions of an assumed preaccident spike; and
 - (2) The concentration is the maximum equilibrium value permitted for continued full-power operation.

As a result of the MSLB accident, fuel failures can occur releasing fission products into the reactor coolant and thus, making additional activity available for release to the atmosphere. The RSBSRXB³² reviews the effects of the MSLB on the core thermal margins and the associated amount of fuel failures. RSBSRXB,³³ as a secondary review branch, will inform the AEBPERB³⁴ of the fuel failure estimate. If the MSLB accident is predicted to cause such fuel failure, a dose analysis will be performed with the corresponding iodine activity. No decontamination factor or other reductions in the concentrations are assumed in the staff's analysis.
 - c. The appropriate atmospheric dispersion factors (χ/Q values) for the staff's independent dose analysis will be determined by the assigned meteorologist in accordance with SRP Section 2.3.4.
3. Comparison of the doses calculated by the applicant and the staff for the two iodine concentrations discussed above with the appropriate acceptance criteria in subsection II of this SRP section. If the doses calculated by the staff exceed those of the exposure guidelines, then the staff will reduce the primary coolant iodine concentration limits in the plant specific technical specification accordingly.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and

acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.³⁵

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided by the applicant and that the applicant's analysis and the staff's independent calculations support conclusions of the following type, to be included in the staff's safety evaluation report (SER)³⁶ at the ~~operating license~~OL³⁷ or COL³⁸ stage:

The staff concludes that the distances to the exclusion area and low population zone outer boundaries for the (insert PLANT NAME) site, in conjunction with the operation of the dose mitigating ESF systems, are sufficient to provide reasonable assurance that the calculated radiological consequences of a postulated main steam line failure outside the containment of the (insert PLANT NAME) station do not exceed (a) the exposure guidelines as set forth in 10 CFR ~~Part 100, §100.11(a)~~³⁹ for the case that the failure occurs with a preaccident iodine spike, and (b) 10% of these exposure guidelines for the case that the failure occurs with a primary coolant activity corresponding to the maximum equilibrium concentration for continued full-power operation as stated in the standard technical specifications for the (insert NSSS VENDOR) design. The staff will review the (insert PLANT NAME) specific technical specifications to ~~assure~~ensure⁴⁰ that the dose guidelines stated above are not exceeded. The results of the staff's calculations are listed in Table 15._____.

This conclusion is based on (1) the staff review of the applicant's analysis of the radiological consequences, (2) the independent dose calculation by the staff using appropriate regulatory positions of Regulatory Guide 1.5 and conservative atmospheric dispersion factors as discussed in Chapter 2 of this report, and (3) the (insert NSSS VENDOR) standard technical specification for the iodine concentration in the reactor coolant consisting of a maximum allowable limit and a limit for the equilibrium concentration for continued plant operation.

For a standard design certification review, the following paragraph is included in the staff's SER:

The staff has calculated hypothetical offsite radiological consequences of the main steam line failure using limits on coolant radioactivity from the proposed technical specifications and atmospheric diffusion parameters specified in the site parameter envelope. The hypothetical offsite consequences are within the guidelines of 10 CFR Part 100.⁴¹

At the construction permit stage, the following paragraph is included in the staff's ~~safety evaluation report~~ SER:⁴²

On the basis of our experience with the evaluation of steam line failure accidents for boiling water plants of similar design, we have concluded that the consequences of these

accidents can be controlled by limiting the permissible primary coolant radioactivity concentrations so that potential offsite doses are small. We will include appropriate limits on the primary coolant activity concentrations in the technical specifications.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.⁴³

V. IMPLEMENTATION

The following provides guidance to applicants and licensees regarding the staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.⁴⁴ Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.⁴⁵

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guide.

VI. REFERENCES

1. 10 CFR ~~Part 100, Paragraph 11~~100.11,⁴⁶ "Determination of Exclusion Area, Low Population Zone, and Population Center Distance."
2. Regulatory Guide 1.5, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors."

SRP Draft Section SECTION
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Editorial	Deleted "SECTION" from title of SRP Section in conformance with standard format for the overall Standard Review Plan.
2.	Current PRB name and abbreviation	Changed PRB to Emergency Preparedness and Severe Accident Branch (PERB).
3.	Current SRB abbreviation	Changed SRB to SRXB.
4.	Editorial	Changed "assure" to "ensure."
5.	SRP-UDP format item	Added "Review Interfaces" to AREAS OF REVIEW and organized in numbered paragraph form.
6.	Current review branch abbreviation	Changed review branch to SRXB.
7.	Current review branch abbreviation	Changed review branch to SRXB.
8.	Current PRB abbreviation	Changed PRB to PERB.
9.	Current review branch name and abbreviation	Changed review branch to Technical Specifications Branch (TSB).
10.	Editorial	Defined "SRP" as "Standard Review Plan."
11.	Editorial	Added standard paragraph on review interfaces between PRBs.
12.	Editorial	Defined NSSS.
13.	Editorial	Corrected format for 10 CFR 100.11.
14.	SRP-UDP format item	Deleted reference to Ref. 1.
15.	SRP-UDP format item	Added metric units.
16.	Integrated Impact # 121	ICRP 2 was superseded by ICRP 30 in 1989. The ICRP 2 document is referenced in Regulatory Guide 1.5 which should be updated if a detailed comparison of the two supports the more recent standard.
17.	SRP-UDP format item	Delete reference to Ref. 2.
18.	SRP-UDP format item	Added "Technical Rationale" to ACCEPTANCE CRITERIA and organized in numbered paragraph form to describe the bases for referencing the regulations.
19.	SRP-UDP format item	Added lead-in sentence for "Technical Rationale."
20.	SRP-UDP format item	Added technical rationale for 10 CFR 100.11.

SRP Draft Section SECTION
Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
21.	Editorial	Deleted reference to recent reviews because there may be none, and a more definitive criterion is the reviewer's determination of safety significance.
22.	SRP-UDP format item	Added standard design certification review per 10 CFR Part 52.
23.	Editorial	Defined GESSAR.
24.	SRP-UDP format item	Added calculation of offsite consequences for a standard design certification using coolant radioactivity specified in the proposed technical specifications and atmospheric diffusion parameters specified in the site parameter envelope.
25.	SRP-UDP format item	Added COL review per 10 CFR Part 52.
26.	Editorial	Added site meteorological characteristics for completeness.
27.	SRP-UDP format item	Added COL review per 10 CFR Part 52.
28.	SRP-UDP format item	Deleted reference to Ref. 2.
29.	SRP-UDP format item	Added metric units.
30.	SRP-UDP format item	Added metric units.
31.	Current review branch abbreviation	Changed review branch to SRXB.
32.	Current review branch abbreviation	Changed review branch to SRXB.
33.	Current review branch abbreviation	Changed review branch to SRXB.
34.	Current PRB abbreviation	Changed PRB to PERB.
35.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
36.	Editorial	Provided "SER" as initialism for "safety evaluation report."
37.	Editorial	Changed because OL was previously defined.
38.	SRP-UDP format item	Added COL review per 10 CFR Part 52.
39.	Editorial	Corrected format for 10 CFR 100.11.
40.	Editorial	Changed "assure" to "ensure."
41.	SRP-UDP format item	Added evaluation findings for a standard design certification review per 10 CFR Part 52.
42.	Editorial	Substituted "SER" for "safety evaluation report."

SRP Draft Section SECTION
Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
43.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.
44.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
45.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
46.	Editorial	Corrected format for 10 CFR 100.11.

[This Page Intentionally Left Blank]

SRP Draft Section SECTION
Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
121	Consideration should be given to performing a detailed side by side comparison between ICRP 2, 1959 and ICRP 30, 1989 to allow SRP reviewers to use the more current version of the standard. (Such a comparison would also support revision efforts for RG 1.5. An IPD 7.0 form has been prepared to address the need to revise RG 1.5.)	Since the ICRP 2 document is not referenced in the SRP, no related changes were made.